FLIGHT TODAY AND TOMORROW. DIRECTIONS AND TOPICS OF ELECTRONIC WARFARE RELATED RESEARCH WORK AT NATIONAL DEFENSE UNIVERSITY

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In this paper author made a challenge to introduce Electronic Warfare (EW) department's efforts to manage the most important research directions and topics, connected to air and cosmic space exploitation.

PREFACE

Main goals of National Defense University's education are the knowledge — like a *today’s skills*, and the research — as a *tomorrow’s promise*. Our department is working in both directions: issues officers having skills to use *today’s* advanced military technology and able to train and guide soldiers, and also lets the best sons to be a scientists solve more difficult tomorrow’s problems. The first part of activities required more diligence and the second more talent without disclaiming necessity of both.

Our department works on mining and teaching the latest novelty, knowledge of advanced military technology, tactics and strategy. That is why we are collecting all NATO doctrines, Field Manuals, Army-, Air Force-, Navy and Maritime Regulations. We add hot information obtained from the latest journals, reviews or periodicals also. Our department has an online electronic library of all gathered information.

Beyond the highest level of education we deal a big part of effort to find now solutions of nowadays a tomorrows challenges. In our opinion: "Without research no successful education, no prosperous economy, no development and no progress". In the Armed Forces the science research must be performed -

first of all - inside, because only a really military skilled person can project the best weapon, can invent how to use it masterly, can understand the situational awareness and "see" the battlefield. At the National Defense University are the faculties and departments - adequate to dispose of deepest knowledge and here are learning every time the best sons of military people.

Especially tough task was (and is) for our department getting through the language barrier. We found out that, who do not speak English language has a big disadvantage. In the 21st Century the World become a "Global Village" where the "Information Societies" must talking in common language.

A few years ago we started a special language training for our students to perform they EW English, help them to understand spoken language and lead them as many as possible time talking in English with foreign colleagues. We made an EW English vocabulary, abbreviations and terms. We also collected some useful texts for grammar exercises. We asked an American friend to read them for listening exercises. All written and voice material is available on CD.

That is why in this conference one of the most important missions is improving our language skills, try to understand each other and talking - far from perfect - but it is the necessary step to reach to the real challenges - military exercises, peacemaking, peacekeeping procedures.

The Internet like an "Information Highway" is the biggest information source. Communication, obtain information, sending cheapest letter and more by E-mail, advertising and making business - all on the Internet they are daily habit for our department. Thanks to Internet we have all of latest (unclassified) FM-s, regulations, pamphlets and articles of EW sources. At our department every teacher has Internet connection, many of them at home also. Our web site is *www.zmne.hu/tanszekek/ehc/indul.htm*. Let's visit us.

RESEACH DIRECTIONS AND TOPICS

Research activities at our department base on wide area of interest — it means much larger, than the today's request of duty. We are analyzing not only solutions of arm, being in Hungarian Army, but all of the worldwide military's examples. Even the education for *today's skills* Preface requires looking forward a few years and more. The students/officers finishing the National Defense University must be prepared for 4–5 year with advanced knowledge. That is why very important to teach the world level up to date technology and tactics. That is why we are trying finding the newest answer for challenge of XXI.

Our department is busy more than 20 exact research direction. (A few of them is shown on the Fig.1.)

- Digital battlefield, digital force of XXI. Century
- Information Warfare
- Command Control Communication Computer Intelligence Surveillance and Reconnaissance (C4ISR)
- Command Control Warfare (C2W)
- Using a Cosmic Space for IEW
- EW against advanced navigation systems
- Spread Spectrum devices
- EW against Low Probability of Intercept (LPI) systems
- Magnetic reconnaissance
- Advanced Imagery Intelligence (IMINT) systems
- All Source Analysis System (ASAS)
- Signal Processing
- Computer Attack C4I systems
- Unmanned Air Vehicle (UAV) for EW
- Cruise Missile Defense (CMD)
- Global Positioning System (GPS)
- Advanced Electronic Deception techniques, tactics
- Electromagnetic Compatibility (EMC) techniques, tactics
- Geographical Information System (GIS) based EW Command Control
- Project EW systems, equipment
- Operation Other than War (OOTW) EW
- Electronic attack equipment
- EW management
- Avoiding combat fratricide - Identification Friend or Foe (IFF): *Battle Combat Identification System (BCIDS); Combat Identification Dismounted Soldiers (CIDDS); Enhanced Position Location Reporting System - EPLRS;*
- Countermeasure against Weapon-guiding systems
- Directed Energy Weapon, Electromagnetic Pulse (EMP)

This is far from complete list of our daily hobbit. We are observing dramatic proliferation electronic devices in military technology. Classification these novelties requires the partitioning EW tasks first of all.

Fig.1. EW and related them for education and research

ELECTRONIC WARFARE TASKS

Electronic warfare any military action involving the use of electromagnetic and directed energy to control the electromagnetic spectrum or to attack the enemy. The three major subdivisions within electronic warfare are:

Electronic attack (EA) uses electromagnetic or directed energy to attack personnel, facilities, or equipment with the intent of degrading, neutralizing, or destroying enemy combat capability. It includes jamming and electromagnetic deception, and employment of weapons that use either electromagnetic or directed energy as their primary destructive mechanism (lasers, radio frequency weapons, and particle beams).

Electronic protection (EP) protects personnel, facilities, and equipment from any effects of friendly or enemy employment of electronic warfare that degrades, neutralizes, or destroys friendly combat capability.

Electronic warfare support (ES) searches for, intercept, identify, and locate sources of intentional and unintentional radiated electromagnetic energy for the purpose of immediate threat recognition. Thus, electronic warfare support provides information required for immediate decisions involving electronic warfare operations and other tactical actions such as threat avoidance, targeting, and homing.

Any EW actions are build upon the comprehensive intelligence gathering. That is why EW and intelligence units are working usually in the same organization - named IEW troops. The various intelligence areas are divided into four intelligence disciplines:

Human Intelligence (HUMINT) is the oldest of the intelligence disciplines. Interrogation and document exploitation is examples of HUMINT operations. Long-range surveillance units, scouts, and patrols may also conduct HUMINT collection.

Imagery Intelligence (IMINT) is the product of imagery analysis. Imagery is derived from, but is not limited to, radar, infrared, optical, and electro-optical sensors. IMINT and imagery systems increase the commander's ability to quickly and clearly understand his battle space. IMINT is an important source of intelligence for intelligence preparation of the battlefield, targeting, terrain and environmental analysis, and battle damage assessment. IMINT is subject to some limitations. Because most imagery requires ground processing and analysis, IMINT may be unable to respond to time-sensitive requirements. Imagery collection also be hampered by adverse the weather and the vulnerability of the platform.

Measurement and Signature Intelligence (MASINT) uses information gathered by technical instruments such as radar's, lasers, passive electro-optical sensors, radiation detectors, seismic, and other sensors to measure objects or events to identify them by their signatures. The Remotely Monitored Battlefield Sensor System (REMBASS) is an example of a MASINT collector.

Signals Intelligence (SIGINT) results from collecting, locating, processing, analyzing, and reporting intercepted communications and non-communications (for example, radar's) emitters. SIGINT provides the commander with valuable intelligence and targeting information on enemy intentions, readiness status, and dispositions by intercepting and locating enemy command, maneuver, fire support, reconnaissance, air defense, and logistics emitters. SIGINT operations require efficient collection management and synchronization to effectively overcome and exploit enemy efforts to protect his critical communications and weapons systems through emissions control, communications operating procedures, encryption, and deception. SIGINT is subdivided into:

communications intelligence (COMINT), electronic intelligence (ELINT) and foreign instrumentation signals intelligence (FISINT).

Counterintelligence (CI) mission is to support force protection. By its nature, CI is a multidiscipline (MDCI) - counter-HUMINT, counter-IMINT, and counter-SIGINT - function, designed to defeat or degrades threat intelligence and targeting capabilities. MDCI is an integral and equal part of IEW.

Collecting, analyzing, and processing information in foreign technological developments obtain *technical Intelligence (TECHINT).* The two parts of TECHINT, battlefield TECHINT and scientific and technical intelligence support commanders at all levels.

Electronic Warfare (together with Physical Destruction, Operations Security, Military Deception and Psychological Operations) is fundamental part of *Command and Control Warfare (C2W).* Electronic attack capabilities allow operational commanders to exploit, deceive, degrade, disrupt, damage, or destroy sensors, processors, communications, C2 nodes, and counter-C2 assets. Spectrum supremacy and delay, denial, or distortion of information in the adversary information system are the objectives. Electronic protect measures allow the friendly C2 nodes to avoid similar hostile EW attack.

Effective EW operation requires numerous condition. A few most important are shown on the fig.2. These requirements are related each other in many another relationships also.

ELECTRONIC PROTECTION EFFECTIVENESS OF AIR/SPACE VEHICLES

EP effectiveness of Air/Space Vehicles depends on the next requirements:

— Against adversary ISR/ESM

Tactics: the Chinese classical writer Sun Tzu (500 BC) maintains:
"All warfare is based on deception. Hence, when able to attack, we must seem unable; when using force, we must seem inactive; when we are near, we must make the adversary believe we are far away; when far away, we must make him believe we are near. Hold our baits to entice the adversary, feign disorder, and crush him."

Sun Tzu's philosophy works today and must be true in the next wars also.
Technology: c*amouflage* air vehicles requires very difficult and expensive technology. Even the today's *Stealth* aircraft can be seen on the B-band radar

displays. The B-band second-radar conception is one of our interesting research directions.

We know NASA technology that would aid the identification of airborne subjects designed to detect turbulence, wind shear and micro burst conditions.

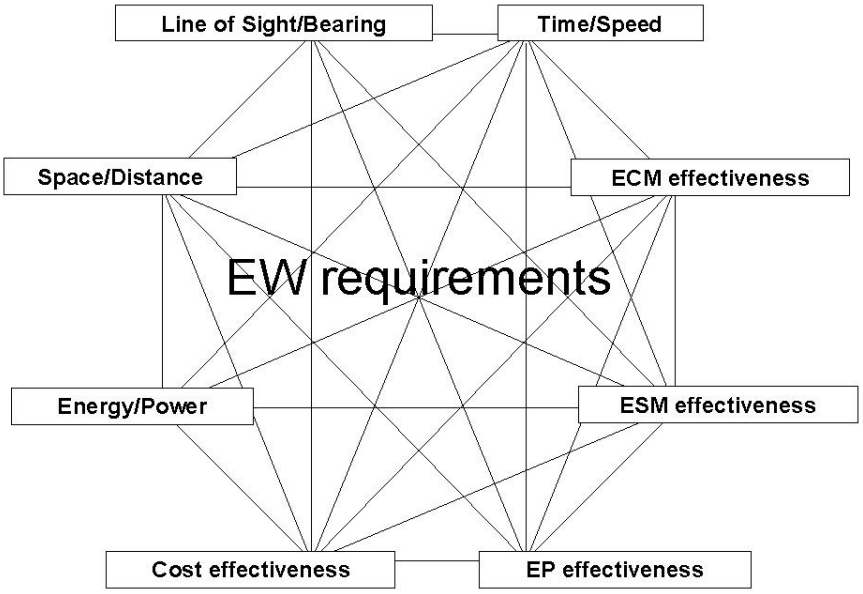

Fig.2. EW requirements of air/space vehicles

This technology could be extrapolated to detect aircraft flights through a given area, coupled with disturbances in the earth's magnetic field, vortex detection tracking of CO_2 vapor trails, and identifying vibration and noise signatures would create a *sensory signature* that could be compared against a data base for classification. Let's think about realization some of them.

— Against hostile ECM

Tactics: for the successful protection friendly air vehicles necessary to know deeply adversary's ECM capabilities which is the main task of TECHINT. It is in close contact with information superiority. I*nformation Superiority* - The capability to collect

- process, and disseminate an uninterrupted flow
- of information while exploiting or denying an
- adversary’s ability to do the same.

It means the next also: air operations planners must be trained in hostile ECM and friendly EP technology.
Technology: for protection air vehicles necessary to use:

- ECM hardening electronic devices on bort
- ECM resistant (radio)communication system
- ECM resistant ISR system
- ECM resistant navigation system.

All of these tasks are parts of our EW department's research interests.

ESM EFFECTIVENESS OF AIR VEHICLES

Tactics: air vehicles and pilots before charge must be fitted to detect all adversaries threat (rocket launching, radar- or laser warning). That is why important task to collect hostile radar transmitters signal. They are stored for library, which is asked before deploying air forces at the same area.

Technology: on the bort must be received all spectrum where hostile threat generated signal can be find (radar radio-wave, heat of rocket-engine). One of the last ESM inventions is UV–seekers to find rocket-, and turbojet radiation.

INTELLIGENCE SURVEILLANCE RECONNAISSANCE EFFECTIVENESS OF AIR/SPACE VEHICLES

Air and space vehicles traditionally the best carries for large scale of ISR devices. The significant advantage of air/space vehicles is the favorable line of sight/bearing, which is, as matter of fact hard to explain in many land-land situation. This is especially important demand in SIGINT (ELINT, COMINT), IMINT, MASINT operations.

One of the most interesting part of our interest is multispectral/hiperspectral imagery intelligence. Multispectral imaging devices was carried first on Landsat I in 1972. It has included image over a small number of broad spectral bands. Imaging spectrometry has gone through considerable development since its origins in multispectral imaging. The spectral resolution, spatial resolution, and detector technology improve successive design, yielding instruments of increasing sophistication. The Hyperspectral Digital Imagery Collection Experiment (HYDICE) is the next generation high resolution, airborne imaging spectrometer. HYDICE covers the spectral range from 0.4-2.5 um, with an average spectral resolution of 10.2 nm. At a design altitude of 6 km, spatial resolution is 3 m over a 936 m swath.

As far as we determined all these part of EW requirements are contributed each other. Development of one of them influence to a few others. When enhanced a few, no one stay without change.

ECM EFFECTIVENESS OF AIR/SPACE VEHICLES

Tactics: ECM effectiveness of air/space vehicles depends on another time/speed, line of sight/bearing, space/distance, energy/power and cost — effectiveness — requirements (see Fig. 2.). Only the well-tailored joint — Air/Land/Sea — operation can be decisive in the XXI century battlefield. Contribution Air–Land, Air–Sea, Air–Air ECM maneuver with Electromagnetic Compatibility (EMC) own troops electronic devices, that is the biggest challenge in the digital battlefield.

Technology: beside passive chaffs the active towed decoys (DASA) and guided false targets proliferation is seemed. They are repeating radar signal more intensive than aircraft's fuselage so bring to itself attention of radar guided weapons.

Today’s "Generation X" self-protection electronic countermeasures are sophisticated digital systems designed to operate covertly and have the ability to both control the victim radar and manage its response. ECM pods offer the ability to provide dedicated cooling for the jamming transmitters and reduced integration/installation losses for increased jamming power. The pod concept also provide multiplatform capability by minimizing the need to outfit every strike aircraft with an internal ECM system. The 2000–and–beyond threat is dynamic and responsive. Generation-X ECM systems face a "rainbow threat," combining technologies and platforms from multiple countries and design philosophies. Seamless integration of the EW suite will take advantage of digital receiver, advanced processing architectures and multifunction antenna designs to break down traditional situational awareness, radar warning and jamming functional boundaries.

Our department is working on new generation of air vehicles carrying ECM and other IEW pods. This is a "helicopter-looks" remote controlled, unmanned air vehicle with 25 kg payload weigh, maximum2500 m high and 100 km radius capability. This UAV will make a revolution not only in Hungarian Army's IEW and other military, but civilian need also (rescue, catastrophe, disaster, finding loosing people, coast- and boarder guard). In this project is taking part numerous university's departments and institutes.

CONCLUSION

This paper can be only an information list of our EW department's effort to change and develop electronic warfare related topics and directions in the National Defense University's global research program. Many of them are cultivated by our department's students, aspirants for Ph.D. degree, teachers and associated research workers.

We are deeply sure that success of education requires a large amount of science research results. Our department supports all initiation directed to develop IEW tactics and technology. We organize conferences — as rule as two times a year — where our results are reported and followed a special issued paper.

We call for cooperation departments, research workers, students from another profession interested in EW related them. We are waiting aspirants for Ph.D. course in large scale of theme.

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